COMMITTEE ON SCIENCE
SUBCOMMITTEE ON ENERGY
U.S. HOUSE OF REPRESENTATIVES

HEARING CHARTER

The Future of University Nuclear Science and Engineering Programs

Tuesday, June 10, 2003
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

On Tuesday, June 10, 2003, the Energy Subcommittee of the House Science Committee will hold a hearing to examine the future of university nuclear science and engineering programs, and how those programs might affect the future of the nuclear power industry in the United States. This hearing builds upon H.R. 238, the Energy Research, Development, Demonstration, and Commercial Application Act of 2003, which the Science Committee unanimously approved on April 2, 2003. The bill would authorize increased funding to the Department of Energy (DOE) for several university-based programs targeted at nuclear science and engineering. The structure and funding levels included in the bill generally follow the May 2000 recommendations of the Nuclear Energy Research Advisory Committee (NERAC), an outside advisory committee to the Secretary of Energy. H.R. 238 was subsequently incorporated into the omnibus House energy bill H.R. 6, which passed the House and now awaits action in the Senate. Any differences with the Senate energy bill will need to be resolved in conference.

It is the Administration's stated policy to encourage the expansion of nuclear energy in the United States. Despite this, many of DOE's university nuclear science programs continue to receive the same funding levels that they have for the last several years, even as other portions of the nuclear R&D budget have doubled. The Administration's most recent budget request for university programs is shown in Table 1.

In this hearing, the subcommittee will focus on DOE's support for university nuclear science and engineering programs, and the role they play in sustaining the U.S. nuclear power industry or allowing it to expand. It will explore the following questions:

1. How can we best meet the workforce needs of the future?
2. How should university nuclear research evolve to ensure its vitality? How, if at all, should the Federal research and development programs be modified to support these changes?
3. How do we determine the right level of support for university nuclear programs, including infrastructure such as university research reactors?

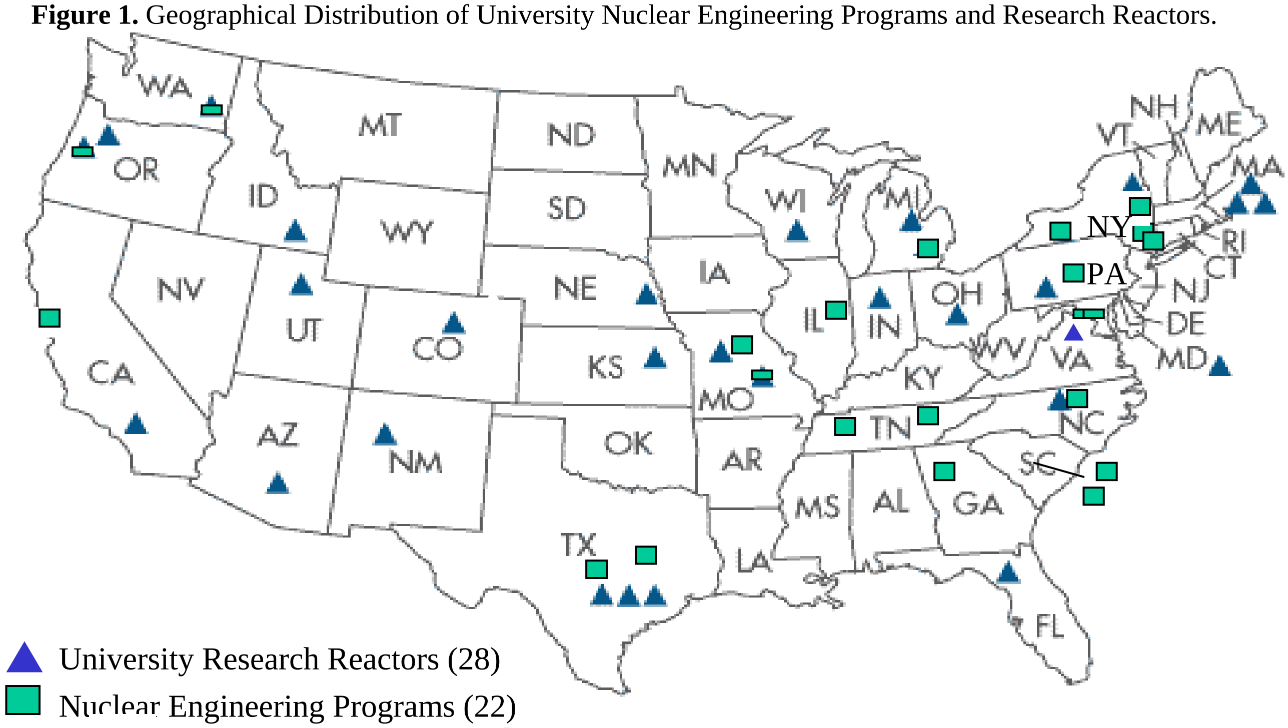
Nuclear Industry Overview

With an installed capacity of 98.1 gigawatts, nuclear power now provides 20 percent of the electricity generated in the United States. Thirty-one states, most in the Eastern half of the United States, are home to nuclear power plants, with five states—New Jersey, Vermont, New Hampshire, South Carolina and New York—producing the largest percentage of their electricity from nuclear power, according to the Nuclear Energy Institute (NEI). The Energy Information Administration forecasts that nuclear generating capacity will increase slightly by 2025, to 99.6 gigawatts, due to nuclear life extensions and uprating of existing plants. However, with the May 2001 announcement that the U.S. federal government will "support the expansion of nuclear energy in the United States as a major component of our national energy policy,"[1] some observers now project a far larger increase in nuclear power. For example, if nuclear energy were to remain 20 percent of U.S. electricity production, nuclear generation capacity would have to increase by more than 60 gigawatts by 2020[2].

DOE University Nuclear Energy Programs

DOE is the sole federal sponsor of university nuclear programs that support the university nuclear engineering programs and research reactors shown in figure 1 below. Funding for programs of particular relevance to this hearing are shown in Table 1 and described below. These programs were authorized by the Committee on Science and are now included in H.R. 6, the omnibus energy legislation that passed the House on April 11, 2003.

Figure 1. Geographical Distribution of University Nuclear Engineering Programs and Research Reactors.



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[1] *National Energy Policy*, Report of the President's National Energy Policy Development Group, May 2001 page 5-17.

[2] Based on EIA demand forecasts for U.S. electricity in AEO 2003.

Table 1. Recent University Nuclear Science and Engineering Budgets *(dollars in millions)*

Program Name	Fiscal Year				
	2002	**2003**	**2004 Request**	**HR6 2004**	**S.14 2004**
NERI†	31.1	25.0	12.0	N/A*	N/A*
University (URFAS)	17.5	18.5	18.5	35.2	33.0
Fellowships	1.4	1.4	1.4	3.0	N/A*
Nuclear Engineering Education Research (NEER)	5.0	5.0	5.0	8.0	N/A*
Innovations in Nuclear Infrastructure and Engineering (INIE)	5.5	6.5	6.5	10.0	N/A*

† This is the total NERI budget of which roughly one third is awarded to universities on a competitive basis.
* Neither HR 6 nor S. 14 break out NERI funding. S. 14 does not breakout funding for programs under URFAS

The Nuclear Energy Research Initiative (NERI) features a competitive, investigator-initiated, peer-reviewed selection process to fund innovative nuclear energy-related research. Modeled after successful research programs, such as those conducted by the National Science Foundation and DOE's Office of Science, the NERI program solicits proposals from the U.S. scientific and engineering community for research at universities, national laboratories, and industry. About one third of NERI's funding goes to university researchers.

University Programs in nuclear science and engineering (identified in the DOE budget as the University Reactor Fuel Assistance Support (URFAS) Program) include:

> *Fellowships:* Funds for undergraduate scholarships and graduate scholarships have been shown to help increase student enrollments in nuclear engineering and related programs. DOE fellowship funding in this program has remained constant for six years. The fiscal year 2004 request would support about 25 graduate students at research universities.
>
> *The Nuclear Engineering and Education Research Program (NEER)* was re-funded in fiscal 1998. In 1993, funding for this broad-based university science grants program had ceased. Since its renewal, NEER has been a major source of research funding for the academic nuclear science and engineering community. These research grants cover areas of basic nuclear science and engineering research and augment the more application-oriented programs funded through NERI. The NEER program has been funded for the past five years at $5 million, supporting one out of every ten competitive proposals in a given year.

<u>*Innovations in Nuclear Infrastructure and Engineering (INIE):*</u> In 2002, the DOE initiated the INIE program to support regional university research reactor (URR) centers. Seven regional URR consortia, distributed across the country, were selected through an independent peer-review panel for funding. In fiscal year 2002, DOE provided funding for four consortia. The fiscal year 2003 funding did not increase enough to initiate funding for the remaining three URRs. One of these, the University of Michigan, will shut down and decommission its reactor in July 2003.

<u>Issues</u>

***People*:** One of the most important questions in considering the appropriate size of DOE's university programs is how many nuclear scientists and engineers are needed. Clearly, the answer depends in large measure on the expected size of the nuclear power industry, which currently employs about 2,000 nuclear engineers. If the industry expects to grow, the demand for nuclear engineers might be expected to grow, too. According to data compiled by the Oak Ridge Institute for Science and Education (ORISE), the number of graduates in the field declined steadily throughout the 1990s. Also, the number of university programs that train students in this area have declined from 87 in 1990 to 37 in 2001. Furthermore, the American Association for the Advancement of Science (AAAS) recently reported that in the next five years the U.S. nuclear power industry could lose as many as 30 percent of its nuclear engineers to retirement.

On the other hand, the ability to predict how many employees the industry will need is complicated by a number of factors. First, the number of engineers needed to run a nuclear power plant has declined. A survey conducted last March by an industry consultant found that utilities intend to replace only about half of all departing employees, making up for the rest by applying new technology, improving processes, etc. Finally, there is disagreement about how much the industry will grow.

Also complicating easy predictions of workforce demand is the tendency of a large portion of graduating nuclear engineers to find employment outside the nuclear power industry (some, for example, work for the military while others work in related careers like health physics). Conversely, not all employees of the industry have nuclear engineering degrees. Nor do they require one, as graduates with other technical degrees have successfully made careers in the nuclear industry. In fact, a recent report by NEI suggests that the future needs of the nuclear industry could be met by such a shift in career choice of a mere 0.25 to 0.35 percent of all graduates with other technical degrees.

Other questions regarding the future nuclear power workforce involve who will compose it. If the U.S. universities cannot meet the demand for skilled graduates, the industry may be forced to turn to foreign students, which could raise concerns about security. Also, the overwhelming number of nuclear engineers in the workforce today is white and male. It is unclear how the culture of the industry will need to change if more women enter the field and how those changes will affect the industry.

Finally, another important question any evaluation of DOE's university programs raises is who should bear the responsibility for workforce training – the government, the industry, or some combination of the two.

Ideas: The health of the nuclear research enterprise can be measured by the number and quality of new ideas in the field. Fewer students and graduates can mean fewer new ideas and ways to cope with important issues such as waste disposal and nuclear proliferation. For example, there are currently only two university professors that have published papers on the use of nuclear energy for producing hydrogen. How the U.S. encourages more effort in such innovative new areas could have important implications for the success of government initiatives, such as the making the transition to a hydrogen economy. A number of questions remain to be answered: In what ways can the government most economically encourage new ideas and research? What role is there for matching funding requirements, whether from states, industry, or the academic community? How do we determine the right level of government support for these efforts?

Tools**:** The nuclear research and education community needs the tools — the facilities and equipment – necessary to carry out its work. How many facilities universities need to train students and conduct research is unclear. One the one hand, the number of university research reactors declined from 64 research reactors in the 1960s, to 27 in 2002 (see Figure 1 for the current locations of university reactors). On the other hand, many of the remaining reactors operate well below capacity. Universities continue to contemplate reactor shutdowns for a variety of reasons, not the least of which is low utilization by the university community. Low utilization, however, could result from several causes: antiquated equipment that has outlived its usefulness, a lack of resources for utilization, or simply a decline in demand generally. Some experts have even questioned the importance of university reactors to training the nuclear workforce of tomorrow, pointing out that numerous successful and well respected nuclear engineering programs do not have an on-campus reactor, and some campuses have a reactor but no nuclear engineering program. Again, a number of questions remain unanswered: What is the right number and distribution of research reactors? Is the research enterprise best served, as it was in the past, by many small reactors, each owned by an individual university; or by a few larger facilities shared by a number of institutions? If the latter, how will smaller colleges and universities fare? Would a shared approach lead to a more rational distribution of infrastructure and promote new ideas, or could it reduce the diversity of ideas that otherwise might develop among independent research groups? How does DOE decide what the right nuclear research infrastructure should be? How does DOE then ensure that these programs will lead to such infrastructure?

Witnesses

The following witnesses have been confirmed for the hearing:

Dr. Gail H. Marcus is the Principal Deputy Director, Office of Nuclear Energy, Science and Technology at the Department of Energy. Dr. Marcus served as President of the American Nuclear Society (ANS) in 2001-2002. Dr. Marcus is a former member of the 1990 National Research Council Committee on the Future Needs of Nuclear Engineering Education. Dr. Marcus also worked at US Nuclear Regulatory Commission (NRC) and the Congressional

Research Service. She also is the first woman to earn a doctorate in nuclear engineering in the United States.

Dr. Daniel M. Kammen holds multiple appointments at the University of California, Berkeley. He is a professor in the Energy and Resources Group, the Goldman School of Public Policy, and in the Department of Nuclear Engineering. He is also the founding director of the Renewable and Appropriate Energy Laboratory. A physicist by training, his work is focused on the scientific and policy issues relating to energy systems, with a particular focus on renewable energy technologies. Kammen served on the Generation IV Roadmap NERAC Subcommittee (GRNS) from 2000 - 2002 for the U. S. Department of Energy.

Ms. Angelina Howard is the Nuclear Energy Institute's executive vice president of Policy, Planning and External Affairs with responsibility for nuclear workforce issues. Before joining NEI, Ms. Howard was with the Atlanta-based Institute of Nuclear Power Operations (INPO). Before joining INPO in 1980, Ms. Howard was employed by Duke Power Company. She has completed the Reactor Technology Program for Utility Executives sponsored by the Massachusetts Institute of Technology and the National Academy for Nuclear Training. She also is a member of the Clemson University Research Foundation Board.

Dr. James F. Stubbins is head of the Nuclear, Plasma, and Radiological Engineering Department at the University of Illinois at Urbana-Champaign, Illinois (UIUC), where he has been a faculty member since 1980–and is the current chair of the Nuclear Engineering Department Heads Organization (NEDHO). He also is a member of the ANS workforce committee and the DOE Nuclear Engineering (NE) University Working Group. Dr. Stubbins has maintained associations as a Faculty Appointee at Associated Western Universities, with Battelle Pacific Northwest National Laboratory in Richland, WA; is a Faculty Appointee at the Division of Educational Programs, Argonne National Laboratory; is an Affiliate of the Los Alamos National Laboratory, and is a Visiting Scientist with Oak Ridge National Lab.

Dr. David M. "Mike" Slaughter of the University of Utah is Chair of the Nuclear Engineering Program and Director of the Center for Excellence in Nuclear Technology, Engineering, and Research (CENTER). He also is the 2001-2002 chair of the National Organization of the Test, Research, and Training Reactors (TRTR).

Questions for the Witnesses

The witnesses have been asked to address the following questions in their testimony.

Questions for Dr. Marcus

- What kind and how large a role in producing the nation's energy does DOE expect the nuclear power industry to play in the future?

- What kind of a workforce, how robust a research enterprise and what kind and how many university research facilities will be necessary to support such an industry? What are DOE's projections for society's nuclear workforce and research needs beyond those directly related to nuclear power?

- To what extent will DOE's university nuclear science and engineering programs, as currently configured, ensure the nation has the necessary workforce and nuclear research base to maintain nuclear power and provide for society's other nuclear needs ? What metrics should policymakers use to determine whether the DOE programs are on target to achieve their goals—especially in the next ten years?

<u>Questions for Dr. Kammen</u>

- What kind and how large a role in producing the nation's energy do you expect the nuclear power industry to play in the future?

- What kinds of innovations or other changes in the industry, in university programs, and in federal nuclear research policy do you believe are necessary if industry is successfully to play that role?

<u>Questions for Ms. Howard</u>

- What kind and how large a role in producing the nation's energy does NEI expect the nuclear power industry to play in the future? How does this projection differ from that of the Energy Information Administration?

- What are the current trends in the number, age, and skills of the nuclear workforce and in the number and availability of university research reactors, and what implications, if any, do these trends hold for the industries ability to achieve the goals that NEI expects?

- How likely are DOE's university nuclear science and engineering programs, as currently configured, to ensure the industry has the necessary workforce and nuclear research base? What changes to these programs, if any, are needed? Other than these programs, what actions should policymakers take to ensure that an adequate workforce is available?

- What steps does industry plan to take to ensure it has the workforce it needs in the future?

<u>Questions for Dr. Stubbins</u>

- What were the most important recommendations the Nuclear Engineering Department Heads Organization (NEDHO) recently made regarding DOE's university nuclear science and engineering programs? What are the implications for the health of university nuclear science and engineering programs and for the nuclear power industry if DOE were to fall short of implementing those recommendations?

- To what extent is the existing university nuclear infrastructure, including nuclear research reactors, sufficient to maintain a vibrant nuclear research enterprise the United States? To what extent is it sufficient to provide the workforce training and research opportunities necessary to sustain the nuclear power industry and provide for other societal needs into the future?

- To what extent does the quality of a university's nuclear science and engineering program depend upon the university having a nuclear reactor? To what extent can the national laboratories and industry support university programs?

Questions for Dr. Slaughter

- To what extent is the existing university nuclear infrastructure, including nuclear research reactors, sufficient to maintain a vibrant nuclear research enterprise the United States? To what extent is it sufficient to provide the workforce training and research opportunities necessary to sustain the nuclear power industry and provide for other societal needs into the future?

- To what extent do you believe DOE uses the right criteria in determining whether to support university research reactors? What changes to DOE's university nuclear science and engineering programs, if any, do you believe are needed?

- To what extent does the quality of a university's nuclear science and engineering program depend upon the university having a nuclear reactor?